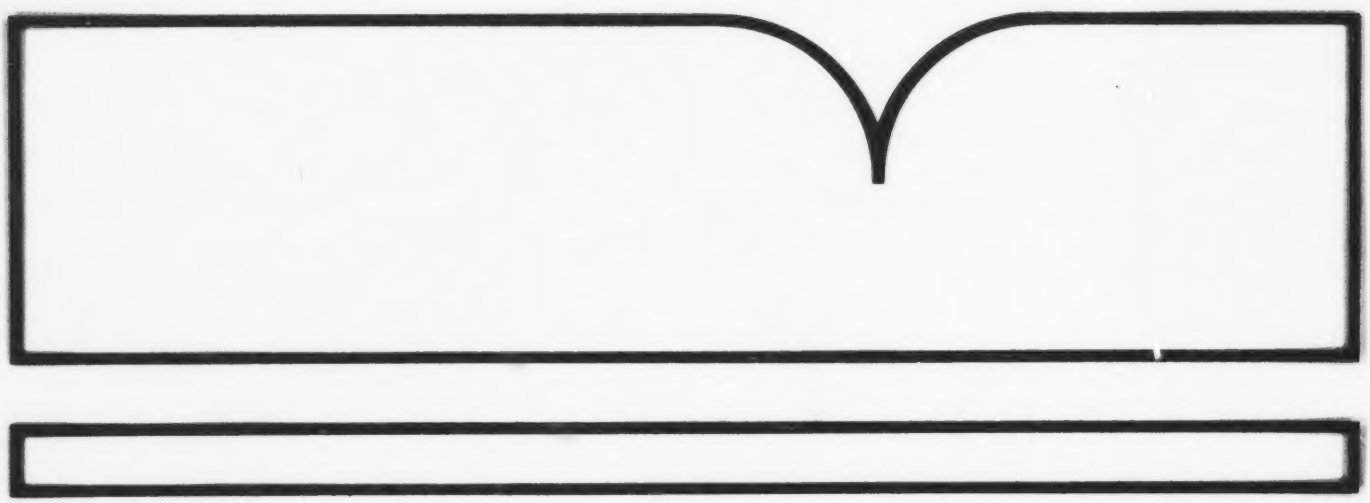
PB88-100516

Heavy-Duty Engine Testing Report
Correlation Testing of Mack EM G-285

(U.S.) Environmental Protection Agency
Ann Arbor, MI

Jan 87



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16. ABSTRACT

This report examines the results of testing the Mack EM G-285 heavy-duty engine at the Environmental Protection Agency Motor Vehicle Emission Laboratory. This heavy-duty engine was tested for the purpose of providing correlation data for the comparison with similar data developed by Mack laboratory. The engine, fuels, test procedures and test plans are also discussed in this report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Diesel Engines Exhaust Emissions Fuels Motor Vehicle Tests	Heavy-Duty Engines Mack EM G-285 Performance evaluation	

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Technical Report

Heavy-Duty Engine Testing Report

Correlation Testing of Mack EM G-285

By

Thomas M. Baines

January, 1987

NOTICE

Technical Reports do not necessarily represent final EPA decisions or positions. They are intended to present technical analysis of issues using data which are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments which may form the basis for a final EPA decision, position or regulatory action.

Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Sources
Office of Air and Radiation
U. S. Environmental Protection Agency

I. Background

The correlation between the heavy-duty test facilities of a manufacturer and EPA's test facilities is of significant interest to both the manufacturer and EPA. It is especially important to establish correlation in this timeframe in that relativity new transient heavy-duty engine testing procedures have been implemented. Thus, EPA/MVEL conducted testing on a Mack engine with the intent of providing correlation data for comparison with similar data developed by Mack. The intent of this report is to summarize this testing program.

II. Engine, Fuels, Test Procedures and Test Plan

The engine that was used in this program was supplied by Mack Trucks, Inc. specifically for this correlation testing. It was a 285 horsepower, in-line six cylinder HD diesel which displaces 672 cubic inches. For charge cooling, it uses a tip turbine-powered air to air intercooler. This tip turbine uses a portion of the turbocharger boost to operate it. The rated speed of the engine is 2100 RPM and the peak torque occurs at 1200 RPM.

The fuel used was a Phillips Reference DF2 known as lot G-463. A copy of the fuel analysis is included in the Appendix. The fuel was presented to the engine at 0 to 0.5 psi and at a temperature less than 100°F. All Federal Test Procedure regulations were used in this testing. The engine was shutdown using the fuel shut off lever and simultaneous dynamometer dial-down. The restrictions were set at an inlet depression of 27.3 inches water and an exhaust backpressure of 2.5 inches mercury. The restrictions were checked after testing was completed and found to be very close to the initial settings.

The test plan for this engine (a copy of which is included in the appendix) called for setting up the engine using the normal engine set-up procedures. This was followed by three sets of a) 1 cold start and three hot starts, b) check restrictions and c) natural cool down. However, Mack reported that when they switched from Phillips lot G-463 to Phillips lot G-580, that they may have experienced a particulate emissions increase. To check this possibility, they sent two barrels of G-580 and requested that EPA perform several tests with this different fuel, which was done. The fuel was introduced to the engine by transferring it from the barrel to the normal fuel delivery system by an auxiliary lift pump.

III. Results

The results from this work are presented in Tables 1 through 5. The reader is encouraged to review these tables, using the following narrative to assist in interpreting the data highlites contained therein.

Table 1 presents the key torque lug map data and resultant integrated reference brake horsepower from both labs. A review of this data shows that both labs had nearly identical map and integrated horsepower results.

Table 2 presents the EPA lab's composite cold start/hot start data which are the "certification" type results for this engine. Mack submitted data on 5 cold starts and 14 hot starts but none of these data were cold start/hot start combinations. Thus, a data comparison between laboratories cannot be made.

Table 3 presents the cold start results. In comparing the results for HC, NOx, BSFC and actual work, the data are quite similar. However, the Mack particulate results were about 23 percent higher.

Table 4 presents the hot start data. Again, there is generally good agreement between the Mack and EPA data with the exception of the particulate results where Mack's data are about 20 percent higher than that of EPA. In response to this observed difference, EPA personnel thoroughly checked the particulate measurement system to see if its operation was contributing to the differences and concluded that it was not.

Table 5 presents the results from EPA's testing of this engine on the fuel supplied by Mack (lot G-580). This was done because when Mack changed to this fuel, particulate levels from this engine appeared to have increased. However, at the same time the fuel lot was changed, Mack changed a number of other test cell parameters and so there was uncertainty as to the influencing factors. Nevertheless, Mack requested that EPA test the engine using G-580 fuel. The results indicate about a 3.5 to 4.7 percent increase in HC, NOx, particulate and BSFC. However, almost all of this could be accounted for by the 3.2 percent drop in work which may have happened independently of the fuel change. Thus, one can conclude that there was almost no change in emissions due to the fuel change.

IV. Conclusions

The following conclusions can be drawn from this work:

- There was good agreement between the two labs with regards to their lug map and associated reference brake horsepower integration.

- There is generally good agreement between the labs on HC, NOx and BSFC.

- There is an unexplained difference in particulate results between the two labs, with Mack results being about 20 higher than EPA's.

- Differences in fuel lots does not explain the particulate result differences.

Table 1

Table of Engine Performance Data
From Testing of the
Mack EM6-285 Correlation Engine

Lab	Curb Idle, RPM	Max HP, BHP	Measured Rated Spd. RPM	Max. Torque Pt. Speed, RPM	Max. Torque Pt. Torque, ft-lb	Integrated Reference Horsepower, BHP-hr
EPA	605	300	1889	1325	1100	20.327
Mack	610	300	1828	1349	1108	20.323

Table 2

Table of Composite Transient
Test Results From
Mack EM6-285
Correlation Engine
EPA Fuel (G-463)

Test No	Emissions, g/BHP-hr. HC	CO	NOx	BSFC, Part.	lb/BHP-hr
3327	0.75	1.60	7.67	0.49	0.426
3330	0.81	1.71	7.87	0.58	0.420
$\bar{X}$	0.78	1.66	7.77	0.54	0.423

Table 3

Table of Cold Start
Transient Test Results From
Mack EM6-285
Correlation Engine
EPA Fuel (G-463)

Test No.	Emission, g/BHP-hr. HC	CO	NOx	Part.	BSFC, lb/BHP-hr	Actual Work, BHP-hr
3327	0.83	1.92	7.52	0.52	0.438	19.529
3330	0.88	2.00	7.89	0.59	0.430	19.655
$\bar{X}$	0.86	1.96	7.71	0.56	0.434	19.592
Mack Results, $\bar{X}$	0.88	2.19	7.23	0.69	0.455	19.48
% Diff.*	2.3	11.7	-6.2	23.2	4.8	-0.6

* Percent difference relative to EPA

Table 4

Table of Hot Start
Transient Test Results From
Mack EM6-285
Correlation Engine
EPA Fuel (G-463)

Test No.	Emission, g/BHP-hr. HC	CO	NOx	Part.	BSFC, lb/BHP-hr	Actual Work, BHP-hr
3327	0.74	1.54	7.70	0.49	0.424	19.601
3328	0.76	1.58	7.41	0.51	0.392	19.708
3329	0.81	1.56	7.37	0.52	0.418	19.745
3330	0.80	1.67	7.86	0.58	0.418	19.839
3331	0.74	1.65	7.63	0.57	0.415	19.836
3332	0.79	1.67	7.69	0.57	0.415	19.842
3333	0.88	1.73	7.52	0.59	0.427	19.072
3334	0.83	1.73	7.58	0.57	0.429	19.059
3345	0.71	1.58	7.21	0.52	0.406	19.947
3346	0.76	1.58	7.18	0.51	0.410	19.891
3347	0.77	1.54	7.24	0.53	0.408	19.918
$\bar{X}$	0.78	1.62	7.49	0.54	0.415	19.678
$(\sigma/\bar{X})(100)$	6.1	4.4	3.0	6.4	2.6	1.62
Mack Results, $\bar{X}$	0.74	1.66	7.46	0.64	0.434	19.54
% Diff.*	-5.1	2.5	-0.4	20.4	4.6	-0.7

* Percent difference relative to EPA.

Table 5

Table of Hot Start
Transient Test Results From
Mack EM6-285
Correlation Engine
Mack Fuel (G-580)

Test No.	Emission, g/BHP-hr. HC	CO	NOx	Part.	BSFC, lb/BHP-hr	Actual Work, BHP-hr
3335	0.81	1.86	7.51	0.57	0.429	19.013
3336	0.81	1.67	8.16	0.56	0.432	19.097
$\bar{X}$	0.81	1.66	7.84	0.56	0.430	19.055
Average of Tests using EPA fuel (G-463)	0.78	1.62	7.49	0.54	0.415	19.678
% Diff.*	3.8	2.5	4.7	3.7	3.6	-3.2

* Percent difference relative to the tests using G-463 fuel.

Appendix

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EPA Torque Map - Table
EPA Torque Map - Graph
Engine Set-Up Sheet
Diesel Fuel Analysis Results (G-463)
Mack Torque Map - Graph
Mack Emissions Results
EPA Individual Emissions Test
Summary Sheets
Mack Letter
Engine Testing Plan

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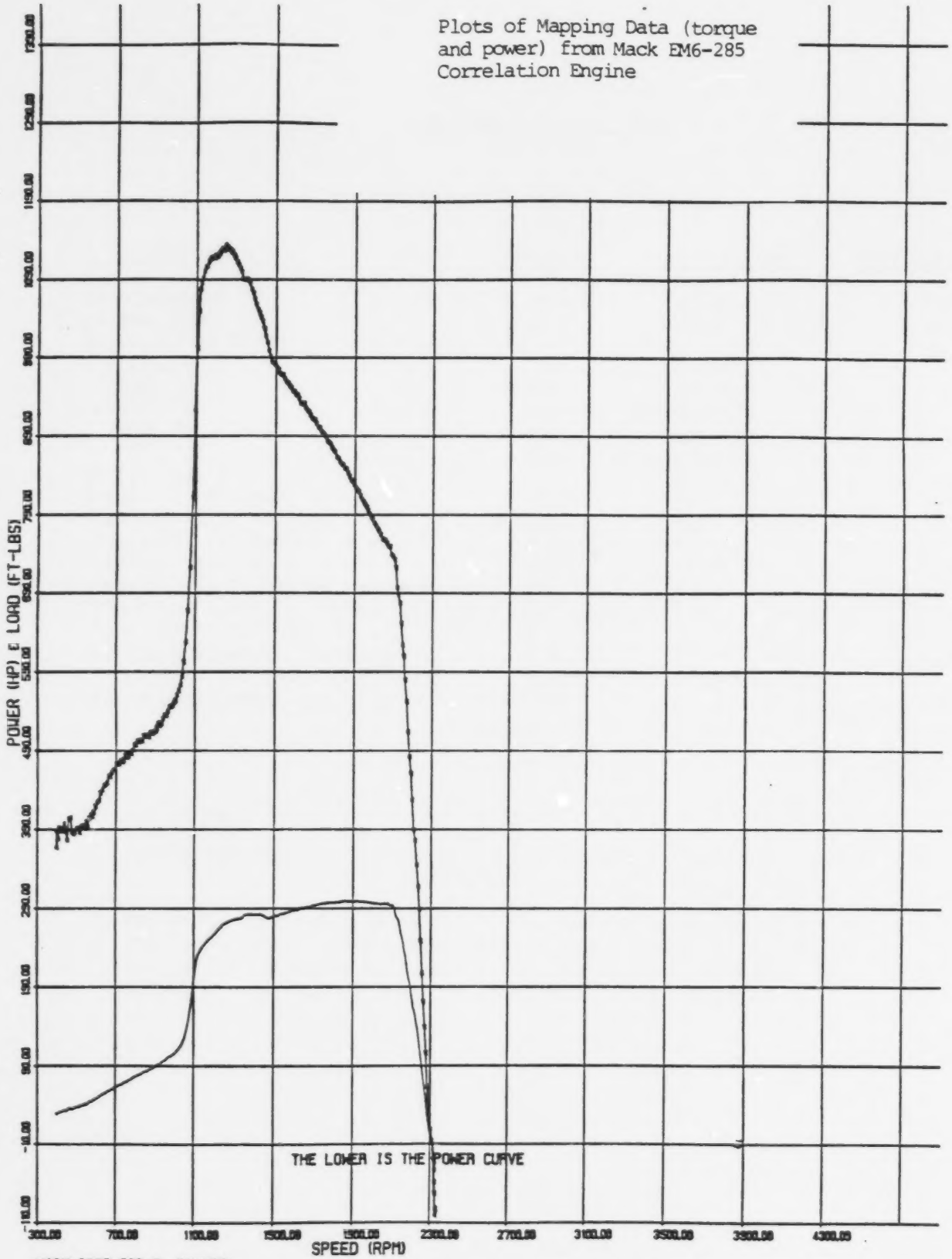
Table of Mapping Data from
Mack EM6-285
Correlation Engine

```
 THERE  ARE ( 248 ) MAPPING DATA POINTS:
 396. 388.0  716. 473.3 1045. 802.5 1379.1077.2 1703. 905.3 2031. 764.5
 397. 367.3  723. 478.1 1055. 628.1 1386.1072.5 1713. 900.5 2040. 758.9
 403. 378.5  732. 476.1 1063. 667.3 1393.1064.5 1720. 900.1 2048. 757.7
 412. 391.7  740. 478.1 1073. 722.5 1401.1058.1 1726. 896.1 2055. 756.9
 418. 388.0  747. 484.9 1086. 812.1 1410.1051.3 1737. 893.7 2063. 753.3
 427. 388.0  755. 481.6 1095. 922.1 1418.1046.9 1745. 890.9 2071. 748.9
 435. 397.7  765. 482.9 1105.1002.1 1425.1041.3 1752. 888.5 2079. 749.3
 442. 390.1  772. 488.9 1111.1050.1 1432.1036.5 1760. 883.7 2087. 738.5
 451. 376.5  779. 486.8 1119.1078.1 1442.1026.9 1767. 881.7 2095. 736.1
 458. 403.7  788. 490.9 1123.1086.5 1448.1017.3 1775. 879.3 2104. 732.1
 468. 404.9  796. 497.7 1131.1092.5 1457.1008.9 1784. 874.5 2111. 722.1
 475. 386.1  804. 497.7 1138.1100.9 1464.  998.5 1791. 871.3 2117. 696.5
 484. 384.1  812. 502.4 1145.1106.5 1471.  991.3 1799. 869.3 2123. 687.3
 490. 386.5  819. 501.3 1153.1107.7 1481.  983.7 1807. 862.9 2133. 676.8
 499. 391.3  828. 502.9 1160.1113.7 1488.  983.6 1816. 860.9 2140. 651.3
 508. 390.9  835. 502.5 1167.1116.0 1496.  980.5 1823. 856.8 2148. 623.7
 515. 386.0  844. 508.5 1176.1118.1 1503.  977.3 1833. 853.6 2154. 609.7
 524. 394.9  851. 508.5 1183.1118.9 1513.  974.5 1840. 852.9 2161. 579.7
 531. 391.3  860. 509.7 1192.1118.1 1520.  969.3 1847. 848.1 2170. 552.0
 540. 390.8  867. 507.7 1199.1120.9 1529.  967.7 1856. 848.1 2177. 513.7
 547. 400.5  876. 513.3 1206.1120.9 1537.  967.3 1863. 842.5 2185. 482.5
 555. 392.9  883. 512.1 1214.1124.1 1545.  962.5 1872. 838.4 2194. 460.9
 564. 404.5  892. 513.7 1222.1127.3 1553.  958.9 1880. 833.3 2200. 427.7
 572. 409.3  901. 515.3 1231.1130.1 1562.  956.9 1886. 832.1 2209. 388.9
 579. 407.3  907. 518.5 1238.1128.1 1569.  953.7 1895. 828.0 2216. 375.7
 586. 412.0  915. 525.3 1246.1134.9 1578.  951.3 1903. 823.7 2225. 344.9
 595. 419.2  923. 522.1 1254.1131.6 1586.  946.5 1912. 820.9 2233. 317.3
 603. 424.9  932. 524.5 1261.1128.9 1592.  946.5 1919. 818.9 2239. 288.9
 613. 427.3  939. 530.9 1270.1127.7 1601.  942.9 1928. 813.7 2247. 248.5
 619. 436.5  948. 535.3 1277.1125.3 1608.  941.3 1935. 809.3 2255. 207.7
 629. 440.5  956. 534.5 1286.1121.3 1615.  937.3 1944. 806.1 2262. 170.9
 637. 446.1  965. 540.1 1293.1117.7 1624.  931.3 1951. 802.5 2270. 138.9
 645. 447.3  973. 545.7 1302.1112.5 1631.  931.6 1960. 799.7 2277. 106.1
 653. 449.7  979. 546.1 1309.1108.5 1641.  931.3 1967. 795.3 2284.  62.9
 662. 458.5  987. 547.3 1318.1104.1 1648.  925.3 1976. 790.9 2294.  26.1
 669. 456.9  995. 550.9 1325.1099.7 1657.  921.7 1984. 786.5 2301.   8.5
 677. 462.9 1004. 553.3 1334.1090.5 1664.  920.5 1991. 784.1 2311.  -6.2
 684. 466.1 1011. 560.9 1353.1089.7 1672.  916.1 1999. 778.9 2319. -29.0
 692. 466.1 1020. 566.5 1354.1090.9 1681.  912.1 2009. 775.3 2323. -58.2
 701. 473.3 1028. 573.7 1362.1088.5 1689.  910.5 2016. 771.3 2326. -72.5
 708. 473.7 1037. 584.5 1369.1084.1 1696.  910.1 2023. 768.9 2328.-100.6
                                                        -     2330. -93.4
                                                              2331. -92.2

<COMMENT>  MAX POWER: 299.7 HP    @ 1856. RPM.
<COMMENT>  RATED SPEED: 1889. RPM.
 WANT A CALCOMP PLOT OF THE MAPPING CURVE? (Y/N): (DEFLT = N): Y

MAPPING DATE =  10/ 07/ 86
ENTER PLOT COMMENT LINE (INCLUDE ENGINE MANUFACTURER AND MODEL):
PLOT OF MACK CORR ENGINE FOR T BAINES #672 MACK
```

Plots of Mapping Data (torque and power) from Mack EM6-285 Correlation Engine



MACK CORR FOR T. BAINES
MAX TORQ =1135 FT-LBS MAX POWER = 299.70 HP MEASURED RATED RPM = 1889.50 MAPPING DATE = 10/ 07/ 88

3 min 55 sec.

D-2 Diesel Control Fuel
Lot G-463

Property	Results	Specification	Test Method
Cetane Number	44.8	43-47	D 613
Cetane Index	46.7	43-47	D 976
Distillation Range			D 86
IBP, °F	374	345-375	
10%, °F	429	400-440	
50%, °F	506	495-525	
90%, °F	591	580-610	
EP, °F	634	630-660	
Sulfur, wt. %	0.31	0.2-0.4	D 2622
Aromatics, minimum	32.3	29	D 1319
Flashpoint, °F minimum	155	130	D 93
Viscosity, centistokes @ 40°C	2.43	2.2-3.2	D 445
Gravity, °API, 60°F	35.1	33-36	D 1298
Copper Strip Corrosion, maximum	No. 1	No. 3	D 130
Oxidation Stability, mg/100 ml, max.	0.4	1.5	D 2274
Cloud Point, Maximum, °F	8	15	D 2500
Particulate matter, maximum, mg/l	1.7	15	D 2276
Carbon Density, grams carbon/gal.	2782	2750-2806(a)	
Net Heat of Combustion, BTU/lb.	19435	Report	D 240

(a) The formula for this calculation is:

$$\text{Carbon Density} = \frac{141.5}{131.5 + \text{API gravity}} \times (\text{Weight Fraction Carbon}) \times 3778$$

Where: Weight fraction carbon is the percent carbon by weight found in the fuel by mass spectroscopy (ASTM D 2789), products of combustion analysis (Pregle analysis ASTM E 191), or equivalent means. 3778 is the weight of 1 gallon of water in grams at 60°F in dry air.

2010E

TRANSIENT CYCLE POWER SWEEP
For Mack EM6-285 Correlation Engine
(Submitted by Mack Trucks; Inc.)

RPM	TORQ	HP	RPM	TORQ	HP	RPM	TORQ	HP
594+	397+	44	1149+	1086+	237	1732+	900+	4[illegible]
603+	399+	45	1157+	1087+	239	1740+	901+	4[illegible]
611+	398+	46	1165+	1112+	246	1749+	900+	4[illegible]
619+	398+	46	1173+	1101+	245	1757+	901+	4[illegible]
625+	410+	48	1181+	1125+	252	1765+	900+	4[illegible]
636+	415+	50	1189+	1110+	252	1773+	899+	4[illegible]
643+	423+	51	1197+	1109+	252	1781+	900+	4[illegible]
651+	418+	51	1205+	1111+	254	1789+	900+	4[illegible]
660+	422+	53	1213+	1133+	261	1797+	900+	4[illegible]
666+	426+	54	1221+	1136+	264	1805+	900+	4[illegible]
674+	435+	55	1228+	1123+	262	1813+	900+	4[illegible]
684+	439+	57	1238+	1142+	269	1821+	900+	4[illegible]
690+	430+	56	1246+	1135+	269	1829+	900+	4[illegible]
700+	439+	58	1254+	1125+	269	1836+	900+	4[illegible]
708+	455+	61	1262+	1127+	270	1844+	900+	4[illegible]
716+	445+	60	1270+	1127+	272	1852+	900+	4[illegible]
723+	451+	62	1278+	1144+	278	1860+	900+	4[illegible]
731+	460+	64	1285+	1130+	276	1868+	900+	4[illegible]
739+	456+	64	1294+	1122+	276	1884+	900+	4[illegible]
747+	449+	63	1301+	1120+	277	1892+	901+	4[illegible]
757+	472+	68	1309+	1132+	282	1900+	917+	4[illegible]
763+	469+	68	1317+	1131+	283	1908+	902+	4[illegible]
771+	460+	67	1325+	1125+	283	1916+	904+	4[illegible]
780+	467+	69	1333+	1117+	283	1923+	904+	4[illegible]
788+	468+	70	1341+	1099+	280	1931+	902+	4[illegible]
796+	481+	72	1349+	1108+	284	1939+	903+	4[illegible]
804+	494+	75	1357+	1088+	281	1947+	904+	4[illegible]
811+	479+	73	1365+	1100+	285	1955+	905+	4[illegible]
820+	488+	76	1373+	1095+	286	1963+	903+	4[illegible]
828+	490+	77	1380+	1086+	285	1971+	903+	4[illegible]
836+	489+	77	1388+	1085+	286	1979+	904+	4[illegible]
845+	486+	78	1396+	1072+	284	1987+	905+	4[illegible]
852+	501+	81	1404+	1052+	281	1995+	903+	4[illegible]
861+	502+	82	1412+	1064+	286	2003+	904+	4[illegible]
868+	489+	80	1420+	1039+	280	2011+	906+	4[illegible]
877+	518+	86	1430+	1035+	281	2018+	907+	4[illegible]
885+	509+	85	1436+	1025+	280	2026+	907+	4[illegible]
891+	496+	84	1445+	1018+	280	2036+	907+	4[illegible]
901+	507+	86	1452+	1011+	279	2044+	908+	4[illegible]
907+	503+	85	1461+	991+	275	2050+	908+	4[illegible]
917+	513+	87	1466+	1006+	281	2058+	908+	4[illegible]
925+	530+	93	1477+	985+	277	2068+	909+	4[illegible]
932+	517+	91	1485+	983+	280	2075+	908+	4[illegible]
940+	538+	96	1493+	980+	280	2082+	910+	4[illegible]
948+	553+	99	1501+	983+	282	2090+	910+	4[illegible]
956+	529+	96	1509+	983+	282	2098+	910+	4[illegible]
965+	548+	100	1517+	975+	281	2106+	913+	4[illegible]
973+	554+	102	1525+	975+	283	2113+	911+	4[illegible]
982+	556+	103	1533+	975+	284	2121+	912+	4[illegible]
989+	546+	102	1540+	973+	283	2129+	913+	4[illegible]
997+	571+	108	1550+	960+	283	2137+	914+	4[illegible]
1005+	572+	109	1558+	960+	284	2145+	914+	4[illegible]
1013+	575+	111	1566+	953+	284	2155+	910+	4[illegible]
1021+	575+	110	1574+	952+	285	2161+	911+	4[illegible]
1028+	555+	108	1582+	946+	285	2167+	911+	4[illegible]
1036+	719+	142	1590+	946+	286	2175+	911+	4[illegible]
1046+	761+	151	1597+	941+	285	2185+	911+	4[illegible]
1056+	809+	162	1605+	941+	287	2193+	911+	4[illegible]
1064+	843+	171	1613+	935+	287	2201+	911+	4[illegible]
1072+	981+	200	1621+	934+	288	2208+	911+	4[illegible]
1078+	1019+	209	1629+	934+	291	2216+	911+	4[illegible]
1086+	1053+	217	1637+	936+	292	2224+	911+	4[illegible]
1094+	1036+	215	1645+	936+	293	2232+	911+	4[illegible]
1102+	1054+	221	1653+	916+	288	2240+	911+	4[illegible]
1110+	1057+	223	1661+	924+	292	2246+	911+	4[illegible]
1118+	1075+	229	1669+	920+	292	2256+	911+	4[illegible]
1125+	1066+	228	1677+	919+	293	2264+	911+	4[illegible]
1132+	1097+	234	1685+	903+	289	2270+	911+	4[illegible]
1141+	1083+	235	1693+	906+	294	2278+	911+	4[illegible]
			1701+	900+	292	2286+	911+	4[illegible]
			1708+	905+	294	2293+	911+	4[illegible]
			1716+	905+	297	2311-	9-	4-

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EM6-285

TRANSIENT EMISSIONS DATA SUMMARY

Submitted by Mack Trucks, Inc.

	HOT RUNS (14)				COLD RUNS (5)			
	MEAN	STD DEV	C.O.V.*		MEAN	STD DEV	C.O.V.*	
BSNOx	7.456	.143	1.91%		7.234	.103	1.42%	
BSHC	.737	.058	7.98%		.881	.080	9.07%	
BSCO	1.657	.082	4.95%		2.194	.066	3.01%	
BSCO (CORR)+	1.685	.046	2.73%		2.252	.082	3.63%	
BSPT	.644	.022	3.46%		.693	.057	8.16%	
BSPT (CORR)+	.655	.026	4.08%		.711	.062	8.69%	
BSCO2	622.2	6.7	1.07%		652.1	4.6	.71%	
HP-hr	19.54	.08	.42%		19.48	.10	.51%	
BSFC	.4336	.0047	1.08%		.4552	.0030	.67%	

+ Combustion Air Humidity

* C.O.V. = STD/MEAN x 100%

TEST NUMBER: HD-863327
TEST DATE/TIME: 10- 9-86 9:12

MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.20 "HG
DRY BULB TEMPERATURE: 77.70 F
ABSOLUTE HUMIDITY: 76.13 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.47	4.38	
EXHAUST+BKG, GM	19.19	18.33	
NET, GM/BHP-HR	0.827	0.740	0.752
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	37.42	30.29	
NET, GM/BHP-HR	1.92	1.54	1.60
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.49	
EXHAUST+BKG, GM	146.36	151.84	
NET, GM/BHP-HR	7.517	7.696	7.670
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.034	
EXHAUST+BKG, GM	13160.30	12843.44	
NET, GM/BHP-HR	626.8	608.2	610.9
PARTICULATE			
SECONDARY TARE, GM	0.167306	0.161744	
SECONDARY PART, GM	0.167535	0.161887	
PRIMARY TARE, GM	0.170273	0.162474	
PRIMARY PART, GM	0.177630	0.169458	
TOTAL, GM/BHP-HR	0.52	0.49	0.49
FUEL CONSUMPTION			
LBS	8.54	8.31	8.35
LBS/BHP-HR	0.438	0.424	0.426
BRAKE HORSEPOWER-HOUR	19.529	19.601	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	0.99457	0.99480
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	3.755	1.635
(LIMIT: +-50 RPM)		
STD ERROR	16.024	15.979
(LIMIT: 100 RPM)		
R-SQUARE	0.99931	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	984	980
SLOPE	0.94466	0.94684
(LIMIT: 0.77/0.83 1.03)		
Y-INTERCEPT	-0.575	-0.375
(LIMIT: +-15 FT-LBS)		
STD ERROR	6.237%	6.191%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.93114	0.93147
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	983	980
SLOPE	0.98076	0.98158
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	-1.959	-1.940
(LIMIT: +-5 BHP)		
STD ERROR	6.868%	6.718%
(LIMIT: 8%)		
R-SQUARE	0.95309	0.95438
(LIMIT: 0.91)		
WORK		
ACTUAL	19.529	19.601
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	20.327	20.327
% DIFFERENCE	-3.93%	-3.57%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 12-12-86 TIME: 09:49:27

DIESEL SUMMARY REPORT

TEST NUMBER: MD-863328 MANUFACTURER: MACK
TEST DATE/TIME: 10- 9-86 12:59 ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.30 "HG
DRY BULB TEMPERATURE: 76.70 F
ABSOLUTE HUMIDITY: 72.47 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	17.72	
NET, GM/BHP-HR	0.000	0.758	0.758
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	31.24	
NET, GM/BHP-HR	0.00	1.58	1.58
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	146.92	
NET, GM/BHP-HR	0.000	7.406	7.406
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	11987.13	
NET, GM/BHP-HR	0.0	561.3	561.3
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.170662	
SECONDARY PART, GM	0.000000	0.170832	
PRIMARY TARE, GM	0.000000	0.166215	
PRIMARY PART, GM	0.000000	0.173454	
TOTAL, GM/BHP-HR	0.00	0.51	0.51
FUEL CONSUMPTION			
LBS	0.00	7.72	7.72
LBS/BHP-HR	0.000	0.392	0.392
BRAKE HORSEPOWER-HOUR	0.000	19.708	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99344
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	3.800
(LIMIT: +-50 RPM)		
STD ERROR	0.000	15.753
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99833
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	990
SLOPE	0.00000	0.92991
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	5.193
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.404%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.92784
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	989
SLOPE	0.00000	0.97605
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.462
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.886%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95301
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.708
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-3.05%

DIESEL SUMMARY REPORT

TEST NUMBER: MD-863329 MANUFACTURER: MACK
TEST DATE/TIME: 10- 9-86 13:35 ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.20 "HG
DRY BULB TEMPERATURE: 77.80 F
ABSOLUTE HUMIDITY: 67.50 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.47	
EXHAUST+BKG, GM	0.00	19.05	
NET, GM/BHP-HR	0.000	0.811	0.811
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	30.76	
NET, GM/BHP-HR	0.00	1.56	1.56
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	148.45	
NET, GM/BHP-HR	0.000	7.374	7.374
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.031	
EXHAUST+BKG, GM	0.00	12690.09	
NET, GM/BHP-HR	0.0	599.5	599.5
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.164381	
SECONDARY PART, GM	0.000000	0.164536	
PRIMARY TARE, GM	0.000000	0.164637	
PRIMARY PART, GM	0.000000	0.171991	
TOTAL, GM/BHP-HR	0.00	0.52	0.52
FUEL CONSUMPTION			
LBS	0.00	8.26	8.26
LBS/BHP-HR	0.000	0.418	0.418
BRAKE HORSEPOWER-HOUR	0.000	19.745	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99476
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	2.035
(LIMIT: +-50 RPM)		
STD ERROR	0.000	15.905
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	978
SLOPE	0.00000	0.95386
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	3.274
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	5.899%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.93778
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	977
SLOPE	0.00000	0.98861
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.503
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.444%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95871
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.745
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-2.86%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863330 MANUFACTURER: MACK
TEST DATE/TIME: 10-10-86 7:50 ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.40 "HG
DRY BULB TEMPERATURE: 74.70 F
ABSOLUTE HUMIDITY: 77.01 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.47	3.47	
EXHAUST+BKG, GM	20.33	18.84	
NET, GM/BHP-HR	0.879	0.796	0.808
CO (BAG)			
BACKGROUND, PPM	0.72	0.96	
EXHAUST+BKG, GM	40.49	34.76	
NET, GM/BHP-HR	2.00	1.67	1.71
NOX (INTEGRATED)			
BACKGROUND, PPM	0.49	0.00	
EXHAUST+BKG, GM	155.65	155.18	
NET, GM/BHP-HR	7.887	7.863	7.866
CO2 (BAG)			
BACKGROUND, PPM	0.035	0.038	
EXHAUST+BKG, GM	13067.18	12943.61	
NET, GM/BHP-HR	615.3	599.7	601.9
PARTICULATE			
SECONDARY TARE, GM	0.168188	0.168551	
SECONDARY PART, GM	0.168393	0.168742	
PRIMARY TARE, GM	0.168138	0.169864	
PRIMARY PART, GM	0.175139	0.176860	
TOTAL, GM/BHP-HR	0.59	0.58	0.58
FUEL CONSUMPTION			
LBS	8.45	8.30	8.32
LBS/BHP-HR	0.430	0.418	0.420
BRAKE HORSEPOWER-HOUR	19.655	19.839	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	0.99390	0.99343
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	3.270	2.993
(LIMIT: +-50 RPM)		
STD ERROR	16.176	15.942
(LIMIT: 100 RPM)		
R SQUARE	0.99930	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	987	995
SLOPE	0.93489	0.92270
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	3.426	7.734
(LIMIT: +-15 FT-LBS)		
STD ERROR	6.488%	6.590%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.92571	0.92450
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	986	995
SLOPE	0.97627	0.97453
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	-1.523	-1.281
(LIMIT: +-5 BHP)		
STD ERROR	7.046%	7.018%
(LIMIT: 8%)		
R-SQUARE	0.95091	0.95141
(LIMIT: 0.91)		
WORK		
ACTUAL	19.655	19.839
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	20.327	20.327
% DIFFERENCE	-3.31%	-2.40%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863331 MANUFACTURER: MACK
TEST DATE/TIME: 10-10-86 9:39 ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.40 "HG
DRY BULB TEMPERATURE: 75.70 F
ABSOLUTE HUMIDITY: 73.34 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.92	
EXHAUST+BKG, GM	0.00	18.12	
NET, GM/BHP-HR	0.000	0.740	0.740
CO (BAG)			
BACKGROUND, PPM	0.00	0.72	
EXHAUST+BKG, GM	0.00	34.00	
NET, GM/BHP-HR	0.00	1.65	1.65
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	152.01	
NET, GM/BHP-HR	0.000	7.631	7.631
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.038	
EXHAUST+BKG, GM	0.00	12828.28	
NET, GM/BHP-HR	0.0	594.2	594.2
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.169644	
SECONDARY PART, GM	0.000000	0.169778	
PRIMARY TARE, GM	0.000000	0.164907	
PRIMARY PART, GM	0.000000	0.171939	
TOTAL, GM/BHP-HR	0.00	0.57	0.57
FUEL CONSUMPTION			
LBS	0.00	8.22	8.22
LBS/BHP-HR	0.000	0.415	0.415
BRAKE HORSEPOWER-HOUR	0.000	19.836	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99371
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	1.971
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.083
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99931
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	987
SLOPE	0.00000	0.94777
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	4.506
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	5.938%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.93835
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	986
SLOPE	0.00000	0.98837
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.621
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.391%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95974
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.836
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-2.42%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863332
TEST DATE/TIME: 10-10-86 10:19

MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.30 "HG
DRY BULB TEMPERATURE: 76.30 F
ABSOLUTE HUMIDITY: 70.19 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.72	
NET, GM/BHP-HR	0.000	0.790	0.790
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	33.88	
NET, GM/BHP-HR	0.00	1.67	1.67
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	154.41	
NET, GM/BHP-HR	0.000	7.686	7.686
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12842.18	
NET, GM/BHP-HR	0.0	594.8	594.8
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.168437	
SECONDARY PART, GM	0.000000	0.168604	
PRIMARY TARE, GM	0.000000	0.167470	
PRIMARY PART, GM	0.000000	0.174478	
TOTAL, GM/BHP-HR	0.00	0.57	0.57
FUEL CONSUMPTION			
LBS	0.00	8.24	8.24
LBS/BHP-HR	0.000	0.415	0.415
BRAKE HORSEPOWER-HOUR	0.000	19.842	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99288
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	3.717
(LIMIT: +-50 RPM)		
STD ERROR	0.000	15.889
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	987
SLOPE	0.00000	0.95089
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	4.493
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	5.827%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.94083
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	986
SLOPE	0.00000	0.98876
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.566
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.322%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.96072
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.842
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-2.39%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863333
TEST DATE/TIME: 10-15-86 9:57

MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 75.80 F
ABSOLUTE HUMIDITY: 57.25 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.70	
NET, GM/BHP-HR	0.000	0.884	0.884
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	32.96	
NET, GM/BHP-HR	0.00	1.73	1.73
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	150.01	
NET, GM/BHP-HR	0.000	7.519	7.519
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12615.93	
NET, GM/BHP-HR	0.0	612.1	612.1
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.168890	
SECONDARY PART, GM	0.000000	0.168994	
PRIMARY TARE, GM	0.000000	0.170203	
PRIMARY PART, GM	0.000000	0.176786	
TOTAL, GM/BHP-HR	0.00	0.59	0.59
FUEL CONSUMPTION			
LBS	0.00	8.15	8.15
LBS/BHP-HR	0.000	0.427	0.427
BRAKE HORSEPOWER-HOUR	0.000	19.072	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99463
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	16.391
(LIMIT: +-50 RPM)		
STD ERROR	0.000	15.942
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	987
SLOPE	0.00000	0.95458
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-15.228
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	5.851%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.94083
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	986
SLOPE	0.00000	0.98238
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-4.539
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.445%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95866
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.072
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-6.17%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863334
TEST DATE/TIME: 10-15-86 10:39
MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 76.20 F
ABSOLUTE HUMIDITY: 56.58 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	4.07	
EXHAUST+BKG, GM	0.00	19.28	
NET, GM/BHP-HR	0.000	0.826	0.826
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	32.94	
NET, GM/BHP-HR	0.00	1.73	1.73
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.49	
EXHAUST+BKG, GM	0.00	152.84	
NET, GM/BHP-HR	0.000	7.581	7.581
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.035	
EXHAUST+BKG, GM	0.00	12675.36	
NET, GM/BHP-HR	0.0	614.4	614.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.166443	
SECONDARY PART, GM	0.000000	0.166595	
PRIMARY TARE, GM	0.000000	0.168051	
PRIMARY PART, GM	0.000000	0.174440	
TOTAL, GM/BHP-HR	0.00	0.57	0.57
FUEL CONSUMPTION			
LBS	0.00	8.17	8.17
LBS/BHP-HR	0.000	0.429	0.429
BRAKE HORSEPOWER-HOUR	0.000	19.059	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99426
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	17.010
(LIMIT: +-50 RPM)		
STD ERROR	0.000	15.779
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99934
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	989
SLOPE	0.00000	0.94131
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-13.386
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.177%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.93392
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	988
SLOPE	0.00000	0.97681
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-4.420
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.677%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95547
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.059
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-6.24%

DIESEL SUMMARY REPORT

TEST NUMBER: MD-863335
TEST DATE/TIME: 10-15-86 13:28
MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 75.10 F
ABSOLUTE HUMIDITY: 57.50 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.46	
NET, GM/BHP-HR	0.000	0.812	0.812
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	31.63	
NET, GM/BHP-HR	0.00	1.66	1.66
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	149.29	
NET, GM/BHP-HR	0.000	7.510	7.510
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12605.10	
NET, GM/BHP-HR	0.0	614.8	614.8
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.166593	
SECONDARY PART, GM	0.000000	0.166722	
PRIMARY TARE, GM	0.000000	0.169722	
PRIMARY PART, GM	0.000000	0.175965	
TOTAL, GM/BHP-HR	0.00	0.57	0.57
FUEL CONSUMPTION			
LBS	0.00	8.16	8.16
LBS/BHP-HR	0.000	0.429	0.429
BRAKE HORSEPOWER-HOUR	0.000	19.013	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99551
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	14.526
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.042
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99932
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	994
SLOPE	0.00000	0.93322
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-13.442
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.324%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.93107
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	993
SLOPE	0.00000	0.97014
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-4.430
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.839%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95310
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.013
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-6.46%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863336
TEST DATE/TIME: 10-15-86 14: 7
MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 75.60 F
ABSOLUTE HUMIDITY: 71.83 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	MS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.94	
NET, GM/BHP-HR	0.000	0.814	0.814
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	31.89	
NET, GM/BHP-HR	0.00	1.67	1.67
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	158.56	
NET, GM/BHP-HR	0.000	8.161	8.161
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12745.53	
NET, GM/BHP-HR	0.0	619.8	619.8
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.163263	
SECONDARY PART, GM	0.000000	0.163369	
PRIMARY TARE, GM	0.000000	0.163705	
PRIMARY PART, GM	0.000000	0.169949	
TOTAL, GM/BHP-HR	0.00	0.56	0.56
FUEL CONSUMPTION			
LBS	0.00	8.26	8.26
LBS/BHP-HR	0.000	0.432	0.432
BRAKE HORSEPOWER-HOUR	0.000	19.097	

CYCLE STATISTICS	CS	MS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99582
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	18.952
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.034
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99931
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	984
SLOPE	0.00000	0.95895
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	-15.831
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	5.774%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.94197
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	983
SLOPE	0.00000	0.98764
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-4.594
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	6.405%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.95934
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.097
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-6.05%

TEST NUMBER: HD-863345
TEST DATE/TIME: 11-21-86 14: 8

MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 73.30 F
ABSOLUTE HUMIDITY: 61.62 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	17.63	
NET, GM/BHP-HR	0.000	0.709	0.709
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	31.52	
NET, GM/BHP-HR	0.00	1.58	1.58
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	149.48	
NET, GM/BHP-HR	0.000	7.206	7.206
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12650.02	
NET, GM/BHP-HR	0.0	582.2	582.2
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.170567	
SECONDARY PART, GM	0.000000	0.170767	
PRIMARY TARE, GM	0.000000	0.168075	
PRIMARY PART, GM	0.000000	0.175166	
TOTAL, GM/BHP-HR	0.00	0.52	0.52
FUEL CONSUMPTION			
LBS	0.00	8.10	8.10
LBS/BHP-HR	0.000	0.406	0.406
BRAKE HORSEPOWER-HOUR	0.000	19.947	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.98743
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	8.418
(LIMIT: +-50 RPM)		
STD ERROR	0.000	38.358
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99603
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	992
SLOPE	0.00000	0.95614
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	1.319
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.733%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.92581
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	991
SLOPE	0.00000	0.99177
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.777
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.352%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.94848
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.947
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-1.87%

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST DATE: 12-12-86 TIME: 09:54:24 HD-863346

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863346
TEST DATE/TIME: 11-21-86 14:34

MANUFACTURER: MACK
ENGINE ID: 760 EM6-285B0CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 72.50 F
ABSOLUTE HUMIDITY: 62.32 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.71	
NET, GM/BHP-HR	0.000	0.758	0.758
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	31.82	
NET, GM/BHP-HR	0.00	1.58	1.58
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	148.18	
NET, GM/BHP-HR	0.000	7.176	7.176
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12696.45	
NET, GM/BHP-HR	0.0	587.4	587.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.172011	
SECONDARY PART, GM	0.000000	0.172108	
PRIMARY TARE, GM	0.000000	0.169839	
PRIMARY PART, GM	0.000000	0.176694	
TOTAL, GM/BHP-HR	0.00	0.51	0.51
FUEL CONSUMPTION			
LBS	0.00	8.15	8.15
LBS/BHP-HR	0.000	0.410	0.410
BRAKE HORSEPOWER-HOUR	0.000	19.891	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.98572
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	10.130
(LIMIT: +-50 RPM)		
STD ERROR	0.000	38.387
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99601
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	992
SLOPE	0.00000	0.96091
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	0.311
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.553%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.92977
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	991
SLOPE	0.00000	0.98915
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.745
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.244%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.94975
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.891
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-2.14%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863347
TEST DATE/TIME: 11-21-86 15:14

MANUFACTURER: MACK
ENGINE ID: 760 EM6-28580CORR672 0

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 75.00 F
ABSOLUTE HUMIDITY: 63.02 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	19.13	
NET, GM/BHP-HR	0.000	0.766	0.766
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	30.74	
NET, GM/BHP-HR	0.00	1.54	1.54
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	148.65	
NET, GM/BHP-HR	0.000	7.237	7.237
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	12697.56	
NET, GM/BHP-HR	0.0	585.4	585.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.166141	
SECONDARY PART, GM	0.000000	0.166301	
PRIMARY TARE, GM	0.000000	0.167027	
PRIMARY PART, GM	0.000000	0.173976	
TOTAL, GM/BHP-HR	0.00	0.53	0.53
FUEL CONSUMPTION			
LBS	0.00	8.13	8.13
LBS/BHP-HR	0.000	0.408	0.408
BRAKE HORSEPOWER-HOUR	0.000	19.918	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.98666
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	6.986
(LIMIT: +-50 RPM)		
STD ERROR	0.000	38.359
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99602
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	996
SLOPE	0.00000	0.94998
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	1.646
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	6.861%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.92329
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	995
SLOPE	0.00000	0.98387
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	-1.680
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.545%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.94555
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	19.918
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	20.327
% DIFFERENCE	0.00%	-2.01%

September 18, 1986

U.S. EPA/SDSB
2565 Plymouth Road
Ann Arbor, MI 48105

Attention: Mr. Thomas Baines

Dear Tom:

Enclosed is information pertaining to the set-up and operation of the EM6-285 Mack correlation engine. In addition, the compiled data for the transient cycle and steady state testing performed at our facility is attached.

Feel free to contact me at (301) 824-6764 if you require any additional information prior to our visit.

Sincerely,

MACK TRUCKS, INC.

Steve

S. S. Trevitz

nk
cc: CKSalter, JWMorris, KEMurphy, GOShetter

SPECIFICATIONS

ENGINE:	MACK EM6-285
SERIAL NUMBER:	ON-4771
DISPLACEMENT:	672 CU.IN.
BORE & STROKE:	4-7/8" X 6"
COMPRESSION RATIO:	15:1
CHARGE COOLING:	SERIES, TIP TURBINE FAN DUCT PROVIDED
RATED POWER:	285 BHP
RATED SPEED:	2100 RPM
PEAK TORQUE SPEED:	1200 RPM
LOW IDLE:	580 RPM
HIGH IDLE:	2300 RPM
GOVERNOR CUT-IN:	2160 RPM
FUEL:	PHILLIPS D-2 CONTROL FUEL LOT G-580, 2 DRUMS SHIPPED
LUBE:	MACK HOUSE LUBE, CRANKCASE FULL AND 5 GALS SHIPPED

THERMOCOUPLES

The engine was shipped with type "J" thermocouples which monitor fuel, oil, compressor discharge air, and intake manifold air temperatures. Additional temperature measurement will be required for cooling water inlet and outlet as well as tip turbine fan inlet. Furthermore, the post-turbine exhaust temperature should be monitored and not permitted to exceed 1200 F.

PRESSURE TAPS

The oil pressure is typically 60 psi in the gallery and 45 psi at piston cooling. Gallery pressure should be monitored by a safety system at a threshold of 30 psi. Fuel pressure to the transfer pump is not critical, but 12 psi is a typical value. The following pressures should be recorded for steady state maximum power tests:

Inlet Air Restriction (Piezometer)
Compressor Discharge
Intake manifold
Exhaust Restriction

ENGINE SPEED

The drive plate on the engine has 60 holes around the circumference to facilitate engine RPM measurement. Maximum overspeed is 2450 RPM.

ENGINE START-UP

Prior to high load operation, the engine should be run at 1200 RPM and 400 lb-ft until the oil temperature reaches approximately 150

ENGINE SHUT-DOWN

Always idle the engine a few minutes before normal shut-down to allow proper cooling of the turbocharger. Stop engine by closing fuel shut-off lever on injection pump.

INJECTION PUMP CONTROLS

Throttle is spring-loaded to idle position. Fuel shut-off is spring-loaded to "run" position.

INSTALLATION OF SHUT-OFF EQUIPMENT

1. Connect the flexible cable sheath to the brass fitting on the air cylinder bracket using the ferrule and nut taped to the sheath.

2. Connect the movable core of the cable to the air cylinder by inserting the core about one inch into the hole in the end of the cylinder attachment and tightening the set screw.

3. Connect house air ($\approx$100 psi) to the inlet of the pressure regulator. Regulator is set to 30 psi.

4. Connect a 12 VDC source to the solenoid valve.

5. With the valve energized, the cylinder should extend. With the cylinder in this position, connect the free end of the center core to the shut-off lever on the injection pump. Clamp the cable sheath to the bracket on the pump while holding the shut-off lever on the pump in the "run" (forward position).

6. De-energize the solenoid valve and see that the shut-off lever goes to the stop position (all the way to the rear).

TEST CONDITIONS

	TRANSIENT AND STEADY STATE EMISSIONS	STEADY STATE MAXIMUM POWER
INLET RESTRICTION	27.3" H_2O	22.9" H_2O
EXHAUST RESTRICTION	33.8" H_2O	33.9" H_2O
FUEL TEMPERATURE	95°F	104°F
TIP TURBINE FAN INLET	60-90°F	60-90°F
INTAKE MANIFOLD AIR TEMP	150°F AVG	AVAILABLE UPON REQUEST
COOLANT*	180°F OUTLET 175°F INLET	180°F OUTLET 175°F INLET

*Mack controls outlet water temp to 180°F on hot engine. Inlet water temp is typically 5°F less. A 180°F termostat was installed on the water outlet. Therefore, EPA should set their water inlet controller to 175°F.

STEADY STATE MAXIMUM POWER

ENGINE SPEED (rpm)	OBSERVED TORQUE (lb-ft)	FUEL FLOW (lb/hr)	AIR FLOW (lb/min) WET	DRY
2100	715	112.0	60.29	59.11
2000	761	110.5	58.27	57.12
1800	852	104.7	51.46	50.45
1600	930	97.7	43.86	43.00
1400	1045	95.5	37.02	36.29
1200	1125	91.5	30.25	29.65
1000	1038	76.7	21.99	21.55

ATOMOSPHERIC CONDITIONS

BAROMETER	29.23" Hg
VAPOR PRESSURE	0.70" Hg
TEMPERATURE	85 DEG. F

TRANSIENT CYCLE POWER SWEEP

RPM	TORQ	HP	RPM	TORQ	HP	RPM	TORQ	HP
+ 594+	397+	44						
+ 603+	399+	45	+ 1149+	1086+	237	+ 1732+	900+	
+ 611+	398+	46	+ 1157+	1087+	239	+ 1740+	901+	
+ 619+	398+	46	+ 1165+	1112+	246	+ 1748+	901+	
+ 625+	410+	48	+ 1173+	1101+	245	+ 1756+	901+	
+ 636+	415+	50	+ 1181+	1125+	252	+ 1764+	901+	
+ 643+	423+	51	+ 1189+	1110+	251	+ 1772+	901+	
+ 651+	418+	51	+ 1197+	1109+	252	+ 1781+	901+	
+ 660+	432+	53	+ 1205+	1111+	254	+ 1789+	901+	
+ 666+	426+	54	+ 1213+	1133+	261	+ 1797+	901+	
+ 674+	435+	55	+ 1221+	1136+	264	+ 1805+	901+	
+ 684+	439+	57	+ 1228+	1123+	262	+ 1813+	901+	
+ 690+	430+	56	+ 1238+	1142+	269	+ 1821+	901+	
+ 700+	439+	58	+ 1246+	1135+	269	+ 1828+	901+	
+ 708+	455+	61	+ 1254+	1126+	270	+ 1836+	901+	
+ 716+	445+	60	+ 1262+	1127+	270	+ 1844+	901+	
+ 723+	451+	62	+ 1270+	1127+	272	+ 1852+	901+	
+ 731+	460+	64	+ 1278+	1144+	278	+ 1860+	901+	
+ 739+	456+	64	+ 1285+	1130+	276	+ 1868+	901+	
+ 747+	449+	63	+ 1293+	1122+	276	+ 1884+	901+	
+ 757+	472+	68	+ 1301+	1120+	277	+ 1892+	917+	
+ 763+	469+	68	+ 1309+	1132+	282	+ 1900+	901+	
+ 771+	460+	68	+ 1317+	1131+	283	+ 1908+	902+	
+ 780+	467+	69	+ 1325+	1125+	283	+ 1916+	901+	
+ 788+	468+	70	+ 1333+	1117+	283	+ 1923+	901+	
+ 796+	481+	73	+ 1341+	1099+	280	+ 1931+	901+	
+ 804+	494+	75	+ 1349+	1108+	284	+ 1939+	901+	
+ 811+	479+	73	+ 1357+	1088+	281	+ 1947+	901+	
+ 820+	488+	76	+ 1365+	1100+	285	+ 1955+	901+	
+ 828+	490+	77	+ 1373+	1095+	286	+ 1963+	901+	
+ 836+	489+	78	+ 1380+	1086+	285	+ 1971+	901+	
+ 845+	486+	78	+ 1388+	1085+	286	+ 1979+	901+	
+ 852+	501+	81	+ 1396+	1072+	284	+ 1987+	901+	
+ 861+	502+	82	+ 1404+	1052+	281	+ 1995+	903+	
+ 868+	489+	80	+ 1412+	1064+	286	+ 2003+	901+	
+ 877+	518+	86	+ 1420+	1039+	280	+ 2011+	906+	
+ 885+	509+	85	+ 1430+	1035+	281	+ 2018+	900+	
+ 891+	496+	84	+ 1436+	1025+	280	+ 2026+	947+	
+ 901+	507+	86	+ 1445+	1018+	280	+ 2036+	945+	
+ 907+	503+	86	+ 1452+	1011+	279	+ 2044+	901+	
+ 917+	512+	89	+ 1461+	991+	275	+ 2050+	901+	
+ 925+	530+	93	+ 1469+	1006+	281	+ 2058+	901+	
+ 932+	517+	91	+ 1477+	985+	277	+ 2068+	901+	
+ 940+	538+	96	+ 1485+	993+	280	+ 2075+	901+	
+ 948+	552+	99	+ 1493+	994+	281	+ 2082+	921+	
+ 956+	528+	96	+ 1501+	944+	269	+ 2090+	927+	
+ 965+	543+	100	+ 1509+	983+	282	+ 2098+	925+	
+ 973+	554+	102	+ 1517+	975+	281	+ 2106+	933+	
+ 982+	556+	103	+ 1525+	975+	283	+ 2113+	901+	
+ 989+	546+	102	+ 1532+	975+	284	+ 2121+	965+	
+ 997+	552+	104	+ 1540+	973+	285	+ 2129+	960+	
+ 1005+	553+	105	+ 1550+	960+	283	+ 2137+	901+	
+ 1013+	577+	111	+ 1558+	960+	284	+ 2145+	901+	
+ 1021+	615+	119	+ 1566+	953+	284	+ 2155+	901+	
+ 1029+	655+	128	+ 1574+	955+	286	+ 2161+	901+	
+ 1039+	719+	142	+ 1582+	955+	287	+ 2167+	940+	
+ 1046+	761+	151	+ 1589+	946+	285	+ 2175+	901+	
+ 1056+	803+	161	+ 1597+	941+	286	+ 2185+	901+	
+ 1064+	843+	171	+ 1605+	941+	287	+ 2193+	901+	
+ 1072+	881+	180	+ 1613+	935+	287	+ 2201+	901+	
+ 1078+	1019+	209	+ 1621+	934+	287	+ 2208+	901+	
+ 1086+	1053+	217	+ 1629+	939+	291	+ 2216+	901+	
+ 1094+	1036+	215	+ 1637+	934+	291	+ 2224+	901+	
+ 1102+	1054+	221	+ 1645+	936+	293	+ 2232+	901+	
+ 1110+	1067+	226	+ 1653+	916+	289	+ 2240+	901+	
+ 1118+	1075+	229	+ 1661+	920+	292	+ 2248+	901+	
+ 1126+	1066+	228	+ 1670+	903+	289	+ 2256+	901+	
+ 1134+	1087+	234	+ 1678+	906+	294	+ 2264+	901+	
+ 1141+	1089+	236	+ 1686+	900+	294	+ 2311+	901+	
			+ 1694+	905+	297			

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EM6-285

STEADY STATE EMISSIONS DATA SUMMARY (2 RUNS)

	2100 - FULL LOAD			1200 - FULL LOAD			1200 - 300 lb-ft	
	MEAN	C.O.V.		MEAN	C.O.V.		MEAN	C.O.V.
NOx (g/hr)	1621	.92%		1942	.66%		752.8	.56%
HC (g/hr)	110	13.7%		13.8	5.1%		39.2	7.98%
CO (g/hr)	326	2.69%		1272	2.86%		59.1	1.23%
CO_2 (kg/hr)	168.8	.03%		134.3	.41%		39.1	5.8%

EM6-285

TRANSIENT EMISSIONS DATA SUMMARY

	HOT RUNS (14)			COLD RUNS (5)		
	MEAN	STD DEV	C.O.V.*	MEAN	STD DEV	C.O.V.*
BSNOx	7.456	.143	1.91%	7.234	.103	1.42%
BSHC	.737	.058	7.98%	.881	.080	9.07%
BSCO	1.657	.082	4.95%	2.194	.066	3.01%
BSCO (CORR)+	1.685	.046	2.73%	2.252	.082	3.63%
BSPT	.644	.022	3.46%	.693	.057	8.16%
BSPT (CORR)+	.655	.026	4.08%	.711	.062	8.69%
BSCO2	622.2	6.7	1.07%	652.1	4.6	.71%
HP-hr	19.54	.08	.42%	19.48	.10	.51%
BSFC	.4336	.0047	1.08%	.4552	.0030	.67%

+ Combustion Air Humidity

* C.O.V. = STD/MEAN x 100%

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

SEP 12 1986

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Mack Correlation Engine Testing Plan

FROM: Thomas Baines, Heavy-Duty Programs Coordinator
Standards Development and Support Branch

TO: Charles L. Gray, Jr., Director
Emission Control Technology Division

THRU: Chester J. France, Chief
Standards Development and Support Branch

1. Introduction: The Selective Enforcement Audit (SEA) group in OMS/MOD places a very high importance on correlation data between a manufacturers' SEA heavy-duty cell and the EPA/MVEL heavy-duty testing cell. Thus, they have requested that EPA test an engine from Mack to correlate the testing facilities at both laboratories. The testing of the Mack engine is of great importance to Mack in that they will use this engine as a calibration engine for their test cells. This test plan is for the testing of this engine.

2. Objective: The objective of this work is to test the Mack engine for correlation purposes and supply the data to MOD/SEA and Mack.

3. Project Scope of Work:

Work Description

Set restrictions
Check power @ WOT, rated & peak torque rpm
Map engine
One Hot Start transient for cycle performance and data
to compare to engine history
Natural cool
1 C/S, 3 H/S
rated RPM, WOT, check restrictions

Natural Cool
1 C/S, 3 H/S
rated RPM, WOT, check restrictions
Natural Cool
1 C/S, 3 H/S
rated RPM, WOT, check restrictions
Steady states - To be determined

Test data taken: All usual emissions and performance.

4. Output: Report memo transmitting data to MOD.

5. Timing: The engine will arrive at our facility in mid-September. The engine should be tested in the most convenient time slot. It is suggested that it be tested after the JAMA round robin engine has been completed.

6. Level of Effort: technicians 100 hours, engineering 20 hours.

7. Additional Comments: The project area for this work should be "SEA + HD recall."

8. Review/Approval:

Review:

Lee Jones _____ Date 9-10-86

Reviewed with Technicians? ✓

Approval:

Charles L. Gray, Jr. _____ Date 9-13

Priority high